Development of High-Performance Graphene-HgCdTe Detector Technology for Mid-wave Infrared Applications

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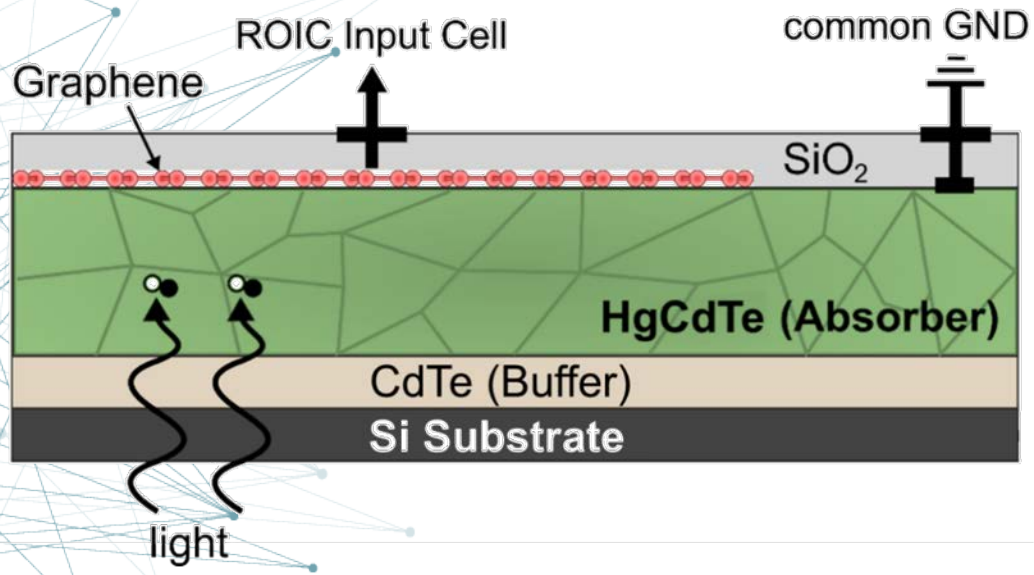
Overview of Technology and Applications

- High performance detector technology being developed for sensing over mid-wave infrared (MWIR) band for NASA Earth Science applications.
- The graphene-based HgCdTe detector technology combines the best of both materials, enabling higher MWIR (2-5 μm) detection performance compared to photodetectors using only HgCdTe.
- Room temperature operation of HgCdTe-based detectors and arrays can provide significantly reduced size, weight, power and cost (SWaP-C) for MWIR sensing applications such as remote sensing and earth observation, e.g., in smaller satellite platforms.

HgCdTe-based Graphene-enhanced MWIR Detector

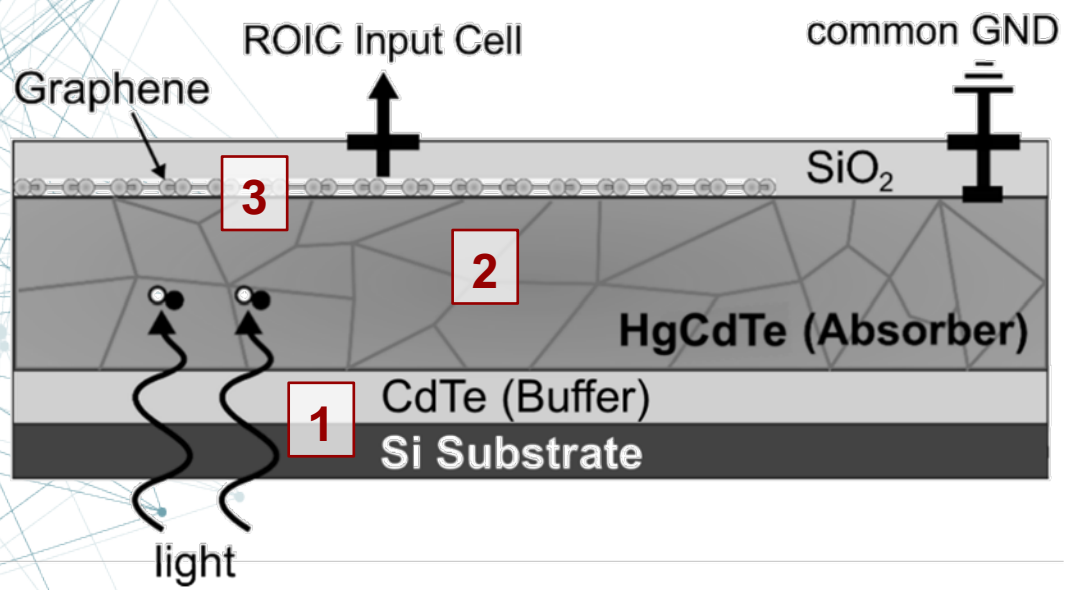


HgCdTe graphene heterostructure based IR photodetector design

- HgCdTe has shown promise for development of MWIR detectors with improvements in carrier mobility and lifetime.
- In addition, HgCdTe layers can be grown using molecular-beam epitaxy (MBE), which yields greater precision in deposition of detector material structures leading to improved electro-optical / infrared performance.

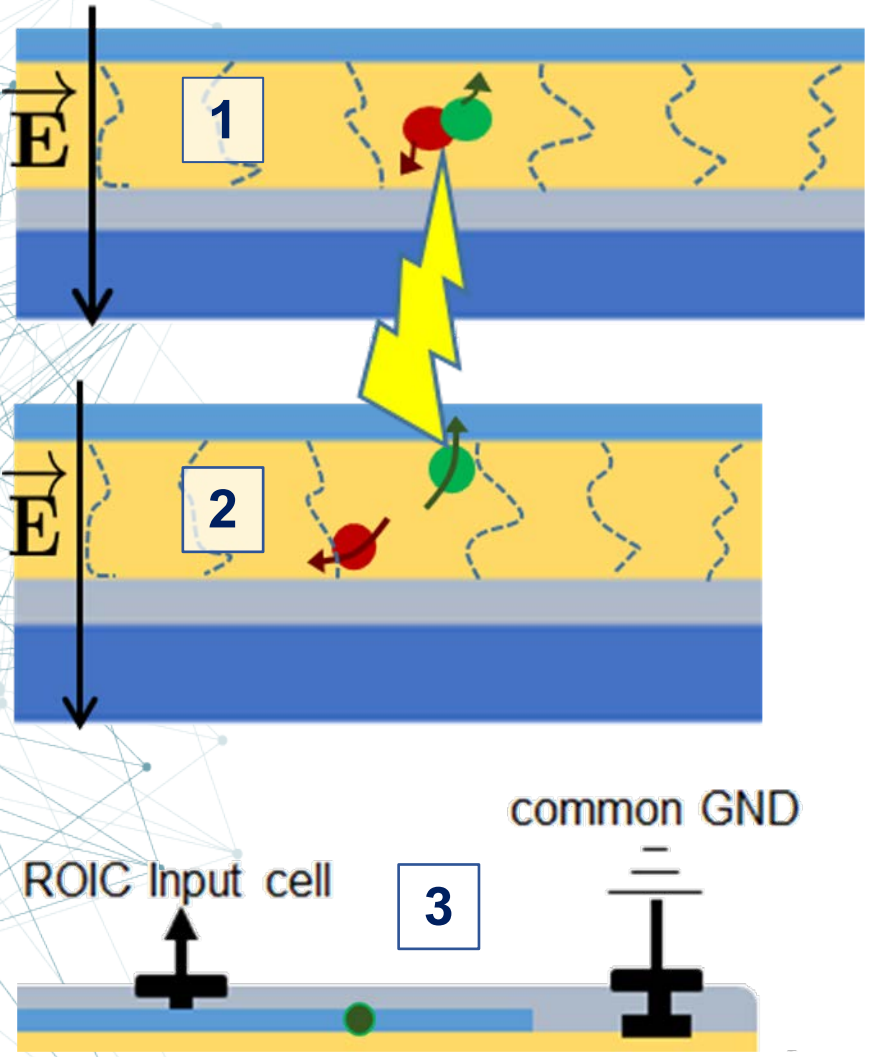
MWIR Detector Material Structure

Graphene-HgCdTe detector structure composed of three principle layers:



1. **Gate (Si/CdTe):**
   - Si layer functioning as gate terminal provides electrical field aiding carrier transport
2. **Absorber (HgCdTe):**
   - Active optical layer where carrier photogeneration occurs
3. **Channel (graphene):**
   - High mobility, low noise graphene channel transfers photogenerated carriers to electrical readout

MWIR Detector Operating Principle



1. **Carrier generation and separation:**
   - Incident IR photons transmitted into HgCdTe absorber produce electron-hole pairs, or excitons
2. **Carrier transport and injection:**
   - Carriers then transported through absorber and injected into graphene
3. **Carrier transport in graphene channel:**
   - Injected carriers transported to and collected by readout integrated circuit (ROIC)

Summary: Graphene-HgCdTe MWIR Detector Technology

- HgCdTe-graphene MWIR detector technology is being developed for NASA Earth Science applications, combining best of both materials.
- Improvements in carrier mobility and lifetime in HgCdTe enable enhanced IR sensing performance.
- Demonstrate high performance HgCdTe-graphene-based room temperature MWIR (2-5 μm) detectors and FPAs with reduced size, weight and power to benefit variety of NASA ESTO applications.